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Scope of Study: The purpose of this report is to explore the subject areas of lapidary applicable to integration into the school shop. A brief history of lapidary is presented to show its origin and importance to man.

Findings and Conclusions: A study in lapidary reveals that there is a wealth of interesting subject material and many valuable learning experiences to be gained from a school course in this subject. The author believes that the subject material contained in this report will aid teachers wishing to formulate a program of this type in their shop. The subject of this report was chosen after the author observed the interest in gem, mineral and gem cutting clubs in southern California.

ADVISORS APPROVAL _____

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LAPIDARY IN
THE SCHOOL SHOP

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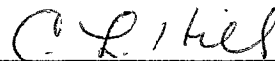
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LAPIDARY IN
THE SCHOOL SHOP

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CHAPTER I

INTRODUCTION

Industrial arts is an ever changing area of education. It is not static. The information taught in industrial arts changes as do the manufacturing processes of industry and the free time activities of the public. It is basic in teaching to appeal to the pupil's interests. In recent years the interest in lapidary has grown enormously.

Lapidary is a subject that appeals to almost anyone. It offers healthful outdoor exercise, adventure in mineral collecting, an introduction to a new area of color and beauty, and a growing knowledge of geography and minerology. Lapidary is the art of cutting and polishing precious and semiprecious stones. A course in lapidary is intended to acquaint students with the methods and processes of identifying, collecting, cutting, polishing, and mounting of gem stones.

It is difficult to make a complete mastery of lapidary, however, anyone can learn to cut gems. Gem cutting has many possibilities for expansion and development provided one learns the basic principles of identification and machining.

Statement of the Problem. The problem is to develop the scope of a lapidary course for the public schools.

Need for the Study. Interest in lapidary is growing rapidly. While there is this interest and need for lapidary to be taught in the

public schools, a majority of industrial art, craft, and art teachers do not have the background necessary for this.

Methods of Investigation Used. Information and materials for this study were obtained from personal and library publications, personal interviews, and visits to various gem and mineral shops throughout Southern California.

Definitions of Terms. To assure a better understanding of the material presented in this report, it is necessary that certain terms be defined. Selected, quoted, and proposed definitions are as follows:

- Bort Diamond dust used for charging diamond saws.
- Cabochon . . A cut stone of any shape, polished smooth without facets.
- Cameo A specimen of gem material or other substance with a carving in relief.
- Dopping . . Cementing a stone on a handling stick.
- Facet A flat surface cut on a gem stone.
- Gem A substance, usually a mineral, suitable, to be cut and polished and capable of being used for personal adornment.
- Lap A flat disc of metal to which loose abrasive is applied for the purpose of fine grinding flat surfaces on stone or other substances.
- Lapidary . . Cutting, engraving, and polishing of precious and semiprecious stones. Also, the name given to the craftsman. From the Latin word lapis for stone.
- Lapping . . The use of a lap with an abrasive to grind.
- Sanding . . The process of smoothing the surface of a stone with an abrasive coated cloth or paper.

Available References. Examination of the Reader's Guide to Periodical Literature from November 1940 to March 1958 revealed that there are over thirty articles on lapidary. The Master's Thesis in Education Reports from 1951 to 1957 identify two studies in lapidary. Visits to

various libraries, gem stores, and mineral and gem societies indicate that there is a wealth of printed subject material.

The enthusiasm shown in mineral collecting societies gives evidence of the need for qualified teachers and planned courses. Printed literature reveals that there are nearly one hundred gem and mineral societies in California and approximately twenty in Los Angeles County.

Lapidary is one of the oldest crafts known to man. A brief historical development of lapidary will serve to illustrate the relationship of lapidary and man.

CHAPTER II

THE HISTORICAL DEVELOPMENT OF LAPIDARY

Various varieties of minerals, because of their variety, durability, and beauty have always been valued by man. Certain stones are so rare and beautifully colored that man has fought and struggled to possess them since the beginning of time.

Egypt. The oldest record of gems was found in the ancient Egyptian tombs. Murals were carved on rock walls of the burial rooms. It was believed the spirits who might some day visit these tombs of dignitaries would find pleasure in the richly designed rooms. According to Egyptian belief, pictures took on properties of real things by virtue of magical formula recited them as part of the funeral rites. The stories in these stone carvings have given an important history of the people of that time.

The jewelry of this time included certain pieces that are not characteristic of any other period. Rings and necklaces were made in this period. However, the pectorial and wig type headdress have never been duplicated. The pectorial was a bronze breast ornament covered with gold leaf, inlaid with gem stones, and suspended from the neck by a ribbon. The headdress was a heavily ornamented wig squarely cut and hanging to the neck with bangs in front.

The jeweler of this time was a highly skilled craftsman. He was a goldsmith, sculptor, and lapidist. The vanity box of the queen and the

king's chariot were covered with hand pounded gold leaf and adorned with stone inlay.

The Egyptians had ideologies of religious evil powers and magic voodoo healing ceremonies wherein jewelry ornaments were often prescribed. Accordingly the religious priest, recognizing the character of the particular demon, would select stone to be engraved with an image of the necessary form. These were pressed against the affected part of the body, thus causing the demon to flee and leaving the person in good health. These rings, necklaces, bracelets, and pendant charms could be compared to the present day rabbits foot and four leaf clovers.

The tools of these craftsmen were simple but effective. Flint and emery fragments were used for free hand scratching on softer stones. Engraving and drilling harder stones was done with hand and bow drills. These drills were tipped with steel grinding ends and revolved against the stone with emery powder as an abrasive.

Wars and foreign invasion put an end to the development of Egyptian art. By 1000 B. C. she was well on her way down hill. Craftsmen continued making old patterns for which there was a good foreign market with the development of ships for Mediterranean sea transportation. The Phoenician merchant ships carried Egyptian jewelry to the Mediterranean countries of Greece, Italy, and Africa.

Mediterranean. The Phoenicians of the ancient country of Syria were active merchant seamen and acted as the middle man for art work not reached by other Mediterranean ships.

After a time the Phoenicians became interested in selling their own crafts and, therefore, trained their own craftsmen. These artists copied from the Egyptians and Babylonians. From the Babylonians they developed

the art of engraving gemstones.

Influenced by the Phoenician traders, the Greeks developed an art for shaping metals and engraving stones. At first they merely copied the work of others but soon developed a creative design of their own.

Greeks like the Egyptians believed in the magic power of precious stones, but had different beliefs toward the healing power of gems. They believed that disease was not caused by evil spirits, but was due to some physical ailment. Their remedy was to grind a stone to powder, mix it with a liquid, and take it orally. Jasper was prescribed for epilepsy with amber and coral for eye and throat trouble.

In the seventh century B. C. the Greeks developed the very difficult art of stone portriature. Cameos were cut in garnet, peridot, ruby, and even emerald. These gem engravers often sculptured full-length figures.

The Italians were also artistic gem cutters. Both men and women wore rings and did fine carving in amber, onyx, and sardonyx. The Romans borrowed freely from other artists and developed a fine quality of lapidary. During this time opal, moonstone, sapphire, garnet, aquamarine, topaz, and peridot were all used as gems of ornament and design.

In the late eighth century the crusaders carried on their mission with such great enthusiasm that was to bring destruction to many of the artists. Even the carved, sacred Christian images were attacked. Many of these lapidaries, and jewelers were given asylum in France and Germany.

Lapidary in the Middle Ages. Craftsmen of the Middle Ages were strongly influenced by the introduction of Christianity. Churches were being built and it became the job of those skilled craftsmen to decorate the House of God. The jeweler of this time was expected to

be a goldsmith, designer, sculptor, and lapidary. Many of these artist-craftsmen were members of the clergy.

During this time groups of Crusaders were going on "rescue" missions to the Holy Land. Among the things rescued were "vast numbers of precious stones and engraved gems" (5 page 74) that found devotional uses in the church. Church interiors and the vestments of the clergy were heavily adorned with gems.

In about the tenth century various groups of craftsmen, including the lapidary, established a guild system for protection of their craft. Each member of the guild was expected to serve a lengthy apprenticeship, finally progressing to a mastercraftsman.

The apprentice served from five to seven years exchanging labor for instruction. After completing his apprenticeship he was expected to work three more years for a small wage as a journeyman.

During the fourteenth century a labor dispute arose between the lapidary and the Venetian glass-worker over the making of beads for rosaries. The glass-worker was able to turn out large quantities of glass beads to each bead made by the lapidary. The decision did not favor the lapidary, however, for he had amber, coral, ivory, and other gem materials which were out of range of the glass-worker.

In addition to rosaries, the lapidary of this time made crucifixes, fruit shaped pendants, brooches, and magic rings. Pendants were often worn as perfume containers to counteract unpleasant odors. Rings engraved with magic symbols and figures were believed to have the power to prevent poverty and cure anything from a toothache to epilepsy.

Renaissance Lapidary. The Renaissance is considered an important revival of artistic and intellectual life. Buildings were being built everywhere and the lapidary often had more work than he could do.

It was during this time that diamonds began to gain popularity. Prior to this period little had been done to change the natural shape of diamonds. In 1497 a man named DeBerquem attracted much attention when he produced several even facet cuts on diamonds. Students trained in the workshop of DeBerquem soon opened shops of their own and carried his influence throughout Europe.

In 1492 Columbus blazed a trail in Mexico and South America for Cortes and other plunderous explorers. Much has been written in history books concerning the fabulous wealth of gold and gems belonging to the Aztecs of Mexico and the Incas of Peru. Historians attribute a large part of the downfall of these ancient cultures to the looting of their treasures. They are said to have had vast quantities of emeralds and pearls.

Lapidary in the 17th, 18th, 19th and 20th Centuries. In the seventeenth century Amsterdam was known as the gem trading center of Europe. Jewish gem merchants who were expelled from Portugal migrated to Holland and continued their work.

Snuff-boxes had a very important influence on the display of gems during the eighteenth and nineteenth centuries. Smoking was considered out of fashion and snuff-boxes richly inlaid with gems became very popular.

Pendants and beads were important items of jewelry. Gem stones have been worn as jewelry by the American Indian since time immemorial. The American Indian, particularly those in the western states, remain today as some of the most skillful gem cutters and jewelry craftsmen.

From the early beginnings in Egypt, the Mediterranean, and Europe have developed one of the fastest growing craft hobbies. Lapidary is not only popular with the home craftsman, it is being added to the art

and industrial arts curriculum of several secondary schools.

Before beginning any lapidary work it is important to understand the nature of gem materials and where they may be found. It is also well to know some equipment dealer addresses and available reference books.

CHAPTER III

GEM MATERIALS AND REFERENCE SOURCES

The lapidary should understand the nature of gem materials and reference sources. Gem stones occur abundantly in mountains, deserts, stream beds, and at the sea shore. Some gems may be produced artificially in the laboratory. Once the lapidary understands his material he should investigate all available reference sources.

Gem Materials. Gem materials used by the lapidist are usually derived from minerals, although some are organic in nature, while others are synthetic. Pearl, coral, and amber are probably the best known organic gems. Coral and pearl come from the animal kingdom, and amber from plant life. Gems hunted in gem fields are highly prized because of the rarity. But they may also be duplicated synthetically. Most common among the synthetic stones are rubies and sapphires.

Sperison states that color is of first importance in a gem stone. (7 page 5) Many stones have the characteristics necessary for being a gem stone, but lack attractive coloring. Minerals in their pure state are often colorless. The variety of color found in mineral stones is due to the impurities of minerals found therein. Some stones are clear, some are multi-colored, and other may only have a colored stripe or zone because of this variation of mineral content.

Gems may be classified according to their ability to transmit light.

Those which permit light to be transmitted freely are transparent; those which transmit only a small amount of light are translucent; and those which completely resist light passage are opaque.

Quality or perfection of gem minerals denotes freedom of flaws, faults, or blemishes. For the determination of the quality of a gem, examination by a magnifying glass is required. Freedom from imperfection is a yardstick of the gem's value.

The rarity of a stone often determines its value. However, this is not always true. Rarity is often stressed, but this is a debatable factor of importance. Turquoise, though scarce is not rare. It might be better to say that if a gem is fashionable it becomes popular and of value. The diamond is probably the only exception to this general fact.

Durability is the stones resistance to shock and wear. For gem stones this durability or hardness has to be higher than that of quartz, which makes up most of the dirt and grit particles in the air. The hardness scale systematized by Fredrick Mohs is generally accepted as follows:

- | | |
|-------------|-------------|
| 1. Talc | 6. Feldspar |
| 2. Gypsum | 7. Quartz |
| 3. Calcite | 8. Topaz |
| 4. Fluorite | 9. Corundum |
| 5. Apatite | 10. Diamond |

Reference Sources. Persons interested in pursuing lapidary as a hobby or incorporating it into their shop program may be interested in sources of information and help. For this reason the author has listed the following lapidary equipment dealers, gemcutting books, and books indicating where gem stones may be found.

Lapidary Equipment Dealers

- Bitner's
Scottsdale, Arizona
- B. and I. Manufacturing Company
Burlington, Wisconsin
- Bouton's Lapidary
Atascadero, California
- Covington Lapidary Engineering
Redlands, California
- Don Bobo's Lapidary Products
P. O. Box 5131
Ballard Station
Seattle 7, Washington
- Diamond Tool Associates
Hawthorne, California
- Ebersole Lapidary Supply
11417 West Highway 54
Wichita, Kansas
- Johnson's Lapidary Equipment
Claremont, California
- Kane Lapidary and Supply
2813 North 16th
Phoenix, Arizona
- M. D. R. Manufacturing Company, Inc.
4853 West Jefferson
Los Angeles 16, California
- Nelson Machine Works
9111 N. E. Halsey Street
Portland 20, Oregon
- Painton's Rockery
Fairview, Oklahoma
- R. and B. Art-Craft Company
11019 R South Vermont Avenue
Los Angeles 44, California
- Technicraft Lapidaries Corporation
3560 Broadway
New York 31, New York
- Vi-Bro-Lap
1401 Fruitvale Boulevard
Yakima, Washington

Gem Cutting Books

FACET CUTTERS HANDBOOK, by Edward J. Soukup
 Gems and Minerals
 Box 687
 Mentone, California

GEM CUTTING, by Captain John Sinkankas
 D. Van Norstrand Company, Inc.
 120 Alexander Street
 Princeton, New Jersey

HOW TO CUT GEMS, by Dan and Marie O'Brien
 O'Brien Lapidary Equipment Company
 1116 North Wilcox Avenue
 Los Angeles 38, California

JEWELRY, GEMCUTTING AND METALCRAFT, by William T. Baxter
 McGraw-Hill Book Company
 330 W. 42nd Street
 New York 36, New York

THE BOOK OF GEM CUTS
 M. D. R. Manufacturing Company, Inc.
 4853 West Jefferson Boulevard
 Los Angeles 16, California

THE DIAMOND SAW AND ITS OPERATION, by Wilfred C. Eyles
 Lapidary Journal
 Box 518
 Del Mar, California

TUMBLING TECHNIQUES, by G. L. Daniel
 Gordon's
 1810 East Anaheim Street
 Long Beach, California

Books Indicating Where Gem Stones May Be Found

ARIZONA GEM FIELDS, by Alton Duke
 Arizona Gem Fields
 Box 1402
 Yuma, Arizona

ARIZONA GEM TRAILS, by J. Ellis Ransom
 Mineralogist Publishing Company
 329 S. E. 32nd Avenue
 Portland 15, Oregon

CALIFORNIA GEM TRAILS, by Darold J. Henry
 Gordon's
 1810 East Anaheim Street
 Long Beach, California

COLORADO GEM TRAILS AND MINERAL GUIDE, by Richard M. Pearl
2679 South York Street
Denver 10, California

ROCKS AND GEMS, by DeWitte Hagar
Trend Books Incorporated
5959 Hollywood Boulevard
Los Angeles 28, California

GEM TRAILS OF TEXAS, by Bessie W. Simpson
Gem Trails of Texas
Box 537
Granbury, Texas

MIDWEST GEM TRAILS, by June Culp Zeitner
329 S. E. 32nd Avenue
Portland 15, Oregon

This chapter has given an explanation of gem materials and available reference sources. With this information as a background, the author will present the methods of processing a gem stone.

CHAPTER IV

THE PROCESSING OF GEMS

Processing a gem means to alter its natural state. There are several methods of processing gem stones. The most common of these are sawing, grinding, sanding, polishing, lapping and faceting, and drilling.

Unit I.

Sawing

The first and often most interesting procedure in lapidary is sawing. Rocks are often ugly with no indication of beauty on the outside and turn out to be very beautiful and interesting when cut open.

Saw Design. Saw design differs with each manufacturer. A wide variety are available. The most suitable saw to use is largely dependent upon how far you want to carry the cutting operation and how much you want to pay. It is possible to finish gem stones with no power equipment whatever.

Certain machine parts are basic to circular gem cutting saws. Saw blades are spindle-mounted and belt driven. Mounted on metal or wooden frames the major assembly includes the spindle, blade, lubricating well, slash guard, and carriage.

Spindles may be of the simplest type with wooden bearings or of a hardened alloy with sealed bearings. The tapered spindle nose has proven

to be very satisfactory since it will permit easy and accurate blade changing.

Coolant tanks are mounted below the blade with liquid at such a level that about one third of the blade edge will dip into it. Tanks should be leak proof, able to withstand vibration, and rust proof.

The splash guard is mounted above the cutting blade to, as the name implies, guard against liquid splash. Some guards are designed to cover the entire top area of the saw and other to cover only part of the splash area. Splash guards should also be rust proof.

One of the most important needs of a saw is an assembly to hold the stone against the saw at an even and constant pressure. The fixture holding the stone is usually a simple wing nut vice with wood blocks for jaws. This clamping device is mounted on the carriage platform. The carriage is spring fed into stone and either bar or roller mounted.

The running speed of the saw is very important, however, it is largely a matter of individual preference. For ten and twelve inch blades the running speeds will vary from 1500 to 6000 S. F. P.M. (surface feet per minute). Most commercial blades are clearly marked with maximum speeds. Willems recommends a medium speed of 500 revolutions per minute for a twelve inch diamond blad. (8 page 37)

Types of Saws. There are various types of saws used to cut hard gem materials. Gem cutting saws may be grouped in two general types: (1) slab saws, and (2) trim saws. Slab saws are used to cut the rough stone. A trim saw which is often called a resaw is used for sectioning slabs for cabochons.

Slab saws. A slabing saw is similar in construction to a woodworking circular saw. Saw blades, however, must be run through a coolant to eliminate friction heat. The saw must therefore be enclosed in a hooded tank

to hold the coolant and protect the operator from splash.

The mudsaw is a type of metal circular disk slab saw. A disk may be made of light iron, mild steel, or galvanized iron depending upon the gauge of metal and the diameter of the disk. This saw is spindle mounted and runs in an abrasive bath held in a container below the saw. The abrasive bath mixture contains silicon carbide grit, water, oil to prevent rust, and often clay or flour to give viscosity. The blade picks up the "mud" and forces it through the stone thus making a cut. Such an abrasive mixture also acts as a coolant. Mud saws, once the standby of industry and the lapidary shop, are not widely in use at the present time.

The fastest and most practical method of sawing is with a diamond impregnated blade. A diamond blade is made of copper or soft steel. Small cuts around the periphery of the disk are charged with small pieces of diamond. Diamond bort (powder) is mixed with a small amount of petroleum jelly, usually vaseline, to hold it together and forced into the cuts. The blade is then rolled, pressed, or heated to close the cuts. As the blade cuts the stone metal is worn away exposing the diamond. Once all the metal holding the diamond charge has been worn away the blade must be recharged or replaced.

It is necessary that the diamond blade also have a liquid bath. The bath acts as a coolant and flushes the debris away from the cutting edge. For several years equal parts of motor oil and kerosene were used as a coolant. New non-rusting, non-inflamable, water soluble commercial coolants are now in wide use. The oil-kerosene mixture has the disadvantages of being difficult to wash from the specimen, subject to evaporation, inflamable, and causing a reaction to the more sensitive skins. Some of the non-rusting cooling agents used in machine shop cutting have proven to be good substitutes for the kerosene-oil mixture. (2 page

For very large specimens a band saw may be used for slab sawing. The saw is similar in most respects to the woodworking band saw. A special blade without teeth is used. This blade is from 1½ to 2 inches in width. Silicon carbide grit is automatically fed into the point of cutting from a hopper above the blade.

Trim saws. A trim saw is considered by Hager to be more important than a slab saw. (3 page 13) Sliced stones may be bought in slab form and other stones are small enough to be cut on a trim in their rough form.

Trim saws are available in a variety of makes and sizes. The average saw blade is six to eight inches in diameter while smaller saws have blades of three or four inches. These saws are similar in construction and operation to a diamond slab saw, with a spindle mounted blade and coolant tank.

Careful consideration should be given to each trimming operation. First, select a cut free of flaws, of good color, and of the best design. Secondly, use care in the method of holding the stone. If the slice of stone is flat it may be pushed into the saw freehand. Irregular pieces should be mounted in dop cement or plaster.

Unit II.

Laying out the cabochon

A careful examination of the slabbed material should be made to determine where the cabochon blank will be taken. Just as the woodworker uses care in selecting grain pattern for a rifle stock, the lapidary should select that portion of a slab with attractive design and color combination.

After selecting a desired cabochon pattern the stone is marked

with an aluminum pencil. Aluminum pencils are used because they will withstand oil and water better than ordinary pencils. These pencils may be purchased commercially or made by sharpening a rod of aluminum on the grinding wheel.

If a stone is to be mounted a template should be used for marking. Plastic templates are available in various shapes of round, oval, and rectangular perforations, with sizes indicated in millimeters. Commercial mountings for gem stones are available in corresponding template sizes.

Some lapidaries become skilled in silver work and fashion their own mountings. This, however, requires additional equipment and is impractical for the average school or home shop.

Unit III.

Dopping

Before a trimmed cabochon may be worked it must be dopped. The purpose of dopping is to mount the cabochon on the end of a stock to facilitate the handling of it. Dopping also provides greater safety and visibility.

Commercial dop wax is used to cement the gem to a handling stick (dop stick). Wooden dowels, large nails, or bolts are used as dop sticks. Most persons prefer dowels because they are cheaper and may be easily cut to the desired length. A small alcohol lamp or Bunsen burner and tweezers are needed as well as the cement and stick. Hold the dop stock in one hand and the stick of wax in the other. Heat the stock of wax in the flame and twirl it to keep it from dripping. Roll the end of the dop stick into the softened wax to form a head of wax on the dop stick. Heat the gem stone slightly while holding it with tweezers and set it in place on the waxed head of the dop stick. While the wax is still hot moisten your fingers and adjust the cooling dopped cabochon.

Care should be taken when removing a finished stone from the dop in order to prevent damage. Soften the wax over a flame and lift it off with the fingers or pry it loose with a knife. Another method of undopping gem stones is to place the stones in a pan of water with ice cubes, or place the stone in the freezing compartment of the refrigerator. After the wax becomes cold and hardens the stone will drop off.

Unit IV.

Grinding

Grinding the gem material into the desired shape is the second operation in gem cutting. Small pebble sized pieces of material may be ground into shape without having been sawed into slabs. Most gem materials are in chunks so large that the pieces must be sliced on a slabbing saw.

Silicon carbide grinding wheels have proven to be the most practical for school or home shop. Diamond impregnated grinding wheels have certain commercial advantages. Diamond wheels are more costly but they may be run at higher speeds and grind a smoother surface. These wheels are recommended where a large quantity of hard gem materials are being worked on a commercial basis.

Grinding wheels may be mounted on each end of a spindle to provide a rough and finished grinding surface. A grit of 100 is most suitable for the first or rough grind, while a grit of 220 is satisfactory for the finer finish grind. (8 page 55)

Silicon carbide wheels should be kept wet with water while in operation. A very satisfactory method of feeding water to the wheels is to connect a small copper tubing to the water outlet or container above the wheel. Water is important to a wheel for the following reasons:

- (1) To prevent overheating. Overheating may cause cracking, fracturing, or the loosening of the gem from the dop.

(2) To flush debris from the surface of the cutting wheel.

A paraffin base oil is used for diamond wheels. Oil permits a faster, cleaner cut than water or water soluble coolants. Dopped cabochons are ground freehand while larger pieces are worked with the aid of a hand or arm rest.

Unit V.

Sanding

A cabochon is sanded in order to remove all surface scratches left by the grinding wheel. Sanding is one of the most important processing steps because it prepares the gem surface for the last finishing procedure - polishing.

The abrasive material used in sanding is a silicon-carbide cloth. Stones may first be sanded on coarse grit cloths of 120 to 180. For finer sanding or for more delicate materials 220 to 320 grit may be used. Very fine, 400 to 600, grit is available but seldom necessary.

Some persons prefer wet sanding while others prefer dry sanding. Wet sanders may be run at higher speeds, but presenting the problem of getting water to the sanding surface. Water is usually sprayed or brushed on the sander. Dry sanding is less expensive and more easily adapted to the school or home lapidary shop.

A sanding cloth need not be changed until it is so smooth that it has no grip on the stone. A worn out cloth will have a smooth, glazed appearance.

The sanding cloth may be mounted on a sanding drum or sanding disk. The abrasive cloth should be fitted over a felt or soft rubber backing which is cemented to the drum or disk. Soft backing material allows the flexible cloth to partially conform to the contour of the cabochon,

thus eliminating flat spots.

The dopped stone is held in the hand the same way a pencil is held. It is then stroked or rotated gently against the sanding cloth. The stone should be in contact with the cloth only for a moment at a time to avoid overheating. Overheating will develop cracks or flaws. After a few passes, the stone should be tested for heat against the palm or forearm.

Unit VI.

Polishing

Polishing is the final step in the processing of the gem. Beauty of color and design are lost if the stone is dull and lifeless. The final polish does to the gem stone what a finisher does to a cabinet maker's desk.

Before the polishing may begin it is necessary to wash both stone and hands carefully. It is even advisable to change your working apron. This cleanliness will help to eliminate sanding grit from being passed to the polishing wheel. When running water is not available then two containers of water should be used. One of these for scrubbing and the other for rinsing.

There are two principle types of polishing disks or wheels: (1) felt, and (2) leather. Wooden and cloth wheels are used to a limited extent, but are considered to be out-dated. Polishing wheels may be vertically or horizontally mounted.

Many polishing agents have been used over the years. Such agents as powdered tripoli, glundum flour, rottenstone, and pumice have been used. Cerium oxide and tin oxide are the most popular general purpose agents in use today.

The polishing agent is mixed into a creamy paste with tap water and this mixture is applied to the revolving wheel with a paint brush. All polishing agents and wheels should be kept covered when not in use. This precaution helps to avoid contamination of the wheel with grit.

The dopped stone is applied to the rotating buff with light pressure. A rotating and sweeping motion is used during the polishing process. The exact pressure and polishing motion will depend upon the operator.

When all visible scratches have been removed the gem stone should be wiped until it is clean. Now, hold it under a strong light or magnifying glass and examine it for scratches.

Unit VII.

Lapping and faceting

Lapping and faceting are methods of cutting flat surfaces by grinding and then polishing on a slow running horizontal wheel called a lap. Lapping produces large flat surfaces such as those needed for bookends, paper weights, pen sets, and table tops. A faceted gem stone is one that has been cut to show many flat "faces" or facets.

There are many types of wheels or laps used for lapping and faceting. Laps may be made of metal, wood or lucite. Essentially, the same types of laps are used for both the lapping and the faceting processes. A lap for lapping is usually larger in diameter than one used for faceting.

The method of holding the gem stone and the skill of the operator are probably the two most important requisites for good lapping and faceting. When lapping hold the free stone by hand. Faceted materials must be dopped and one of several devices is used. Holding devices for faceting may be grouped into two general classifications. The first and oldest is to dop a stone to a stick and work free hand. The second

method is to hold the dop stick by a mechanical holding device. To do good work with the first method requires a great deal of skill. Mechanical holding devices hold the gem at the proper angle and give the worker more accuracy in spacing the facets on the stone.

Lapped or faceted gem stones are first ground with a coarse grit abrasive and then polished with a very fine abrasive. Almost any abrasive powder may be used. Silicon carbide powder is available in a variety of grits and is considered the most common abrasive in use today. The abrasive powder is mixed with water or light oil and is applied to the moving lap by brush.

Faceting is used to allow light to penetrate the stone from various angles and to bring out color and brilliance. The quality of this work depends largely upon the skill of the lapidary, preparation of the gem, and judging the excellence of the polishing.

Faceting should only be attempted by the more advanced lapidary who has mastered cabochon work. Lapping may be attempted at most any stage of learning, however, more success will be found after having some background in cabochon cutting.

Unit VIII.

Spheres

Cutting balls or spheres is another advanced lapidary process. There is probably no better way in which the various colorings and markings may be seen. Some persons have argued that sphere cutting is a form of novelty cutting and does not belong in the same class as gem cutting but it is generally agreed that spheres serve ornamental and useful purposes.

After the gem material has been selected it is cut into a cube on

the slabbing saw. The corners are then sawed off and the material is ground to a ball shape on the coarse grinding wheel.

Once the sphere has been roughed out then one of the two types of apparatus may be used to cut the sphere. The simplest and least expensive apparatus consists of two pieces of pipe machined to a 45 degree angle on the inside. One piece of pipe is attached to an arbor shaft and the other is held in the hand. Wet abrasive grit is then applied as the sphere revolves between pipe ends. Grit may be applied by brush as the sphere turns or by saturated rags which are stuffed into each end of the pipe. If a quantity of spheres are desired it is helpful to use a sphere-making machine.

For larger spheres 100 to 220 grit silicon carbide may be used. When a perfect shape is attained the sphere should be washed clean and then ground further with 400 to 600 grit. The final polishing may be accomplished with a tin oxide or cerium oxide mixture.

Unit IX.

Drilling

Holes have been drilled into stones for thousands of years. Drilling has been greatly simplified by automatic drill presses which are essentially miniature versions of drill presses used in machine shops.

Drills are available commercially or may be made from a variety of materials. Short pieces of wire, sewing machine needles, tubing, and small diamond drills may be used.

The gem material to be drilled should be properly held for the drilling process. It may be clamped to the table of the drill press or set in modeling clay. Adjust the table or depth guage so that the drill stem will barely touch the gem surface. This allows the drill to be set properly

and the hole to be drilled straight.

Silicon carbide or diamond dust may be used as an abrasive. Keep the abrasive mixture in a liquid form and allow the drill to be in contact with the stone for only a few moments at a time.

There are many methods of processing gem stones that have not been presented in this study. The processing methods presented in this report are those which have proven to be the most successful for the author and his associates.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Because of the vast scope of the study of lapidary, only a fraction of the methods, techniques, and materials can be mentioned in this report. There is a wealth of information to be learned in a complete study of the subject and several areas to explore.

Summary of Findings. Lapidary is a fascinating subject which all ages may enjoy. It involves mechanical skill, a feeling for design, and a desire to "make it yourself". This art has grown in popularity in recent years, until it now ranks as the third largest hobby in America. (1 page 13)

For many years the lapidary art was a closely guarded secret carried on only by the guilds in western Europe. Because of this system very little was known or written about the art for many years. Today the craftsman combines mechanical and artistic skills. Science and modern industrial processes have had slight influence on the gem industry, however, the number of smaller lapidary machines on the market today has helped to make this art a growing hobby.

Gem materials used by the lapidary are usually derived from minerals. Various minerals of gem quality may be found throughout most of the United States. Important characteristics in gemstones are: color, quality, rarity, and durability.

The processing of gems includes the phases of sawing, grinding, sanding, and polishing. These processes bring out the true beauty of the gem stone, and are used in cutting cabochons and faceting.

Recommendations and Conclusions. Materials and processes developed in this study lead to the conclusion that a practical course of lapidary could be constructed for the Industrial Arts area. Due to the increasing interest in lapidary, an effective course should be developed to meet the needs of the public schools.

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